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INTERACTIVE RISK ANALYSIS

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ABSTRACT

This paper presents a brief description of a computer program which is available to perform calculations needed in a risk analysis. The model discussed in this paper is one which allows a user to estimate the risk associated with any number of variables and to display the distribution of any arithmetic (addition, subtraction, and (or) multiplication) combination of the variables.

The mode of operation is designed to be similar to a calculator. Rather than entering in a single number, the user must supply a low, most likely and high for each variable. Variables can be added, subtracted, or multiplied; intermediate calculations can be stored; and the distribution of the total can be displayed at any time.

INTRODUCTION

Many point estimates of totals (e.g., project completion time, cost of weapon systems, etc.) involve simple addition, subtraction and multiplication which can be performed on a hand calculator. Commonly, point estimates are made for each subcomponent and totals are calculated. Problems arise when there is uncertainty about the value of the individual component because of lack of information or the inability to accurately forecast the subcomponent. The affect of this uncertainty on the total is captured by risk analysis.

To determine the amount of uncertainty in a total, an analyst would not only estimate the most likely value for each subcomponent but also estimate the probability of different outcomes for each subcomponent. From this information, probabilities of different totals could be calculated. This is exactly what is done in statistical risk analysis. The only difference is in the way that an analyst supplies information about the uncertainty in subcomponents and how this information is used to make probability statements. The complexity of the calculations required make the use of a computer almost a necessity.

Most computer programs available to assist an analyst in performing calculations required in a risk analysis are designed with a particular area of application in mind or require a relationship between the different variables involved to be defined in advance. Either of these requirements limit the flexibility of the software and hence applications.

The computer program discussed in this paper was designed such that

- -no formal training is required on the modeling technique employed,
- -no mathematical equations need to be defined,
- -the operation is similar to a calculator, and
- -the results can be displayed immediately.

The program can be used in numerous areas of applications including, but not limited to, quality control, scheduling, inventory control, and cost analysis.

Interactive Model

The computer program being discussed, accepts three estimates for each subcomponent and allows the user to combine the subcomponents using any sequence of addition, subtraction and multiplication. The three points required are a most likely value (i.e., the value with the highest probability), a low value (i.e., a value which will be underrun only 1% of the time), and a high value (i.e., a value which will be overrun only 1% of the time). When the user has combined the subcomponents in a meaningful fashion the probability of different totals can be requested.

The user has the following commands available:

- -ADD for addition
- -SUB for subtraction
- -MUL for multiplicstion
- -STO for storing intermediate calculations
- -RCL for recalling stored information
- -INP for inputing the three point estimates
- -CON for displaying the contents of storage
- -DIS for displaying probabilities
- -BYE to end program.

Note, there is no hierarchy of operation (i.e., 1 added to 2 and then multiplied by 3 would be 9 not 7).

EXAMPLE

In order to illustrate the interactive risk program, a simple example will be used. The problem is to add two variables together and then to multiply by a third variable. The data for the three variables is shown below.

Variable	Low	Most Likely	High
1	300	400	600
2	100	300	900
3	.1	.3	.5

The actual input and output is shown below. The use of the STO command was not necessary but was used to demonstrate how intermediate calculations can be stored. The underlined portion is the user input.

INTERACTIVE RISK ANALYSIS EXAMPLE

```
COMMAND (mul, add, sub, dis, inp, sto, rcl, con, bye)
? inp
Low, Most likely, and High ? 300,400,600

COMMAND (mul, add, sub, dis, inp, sto, rcl, con, bye)
? add
COMMAND (inp, rcl)? inp
Low, Most likely, and High ? 100,300,900

COMMAND (mul, add, sub, dis, inp, sto, rcl, con, bye)
? sto
Enter numeric storage location? 21

COMMAND (mul, add, sub, dis, inp, sto, rcl, con, bye)
? inp
Low, Most likely, and High ? .1,.3,.5

COMMAND (mul, add, sub, dis, inp, sto, rcl, con, bye)
? mul
COMMAND (inp, rcl)? rcl
Enter Numeric Storage Location? 21

COMMAND (mul, add, sub, dis, inp, sto, rcl, con, bye)
? dis
   PROBABILITY          TOTAL          Most likely value= 2.0194662D+02
   OF EXCEEDING         VALUE                    Mean = 2.4066549D+02
          0.01 5.0070685D+02
          0.05 4.1430178D+02
          0.10 3.7006158D+02
          0.15 3.4109697D+02
          0.20 3.1865877D+02
          0.25 2.9986448D+02
          0.30 2.8337811D+02
          0.35 2.6845837D+02
          0.40 2.5464213D+02
          0.45 2.4161250D+02
          0.50 2.2913463D+02
          0.55 2.1702022D+02
          0.60 2.0510498D+02
          0.65 1.9323140D+02
          0.70 1.8123174D+02
          0.75 1.6890555D+02
          0.80 1.5598177D+02
          0.85 1.4203856D+02
          0.90 1.2628802D+02
          0.95 1.0673596D+02
          0.99 8.1882755D+01
```

The program will allow for up to 10 distributions of intermediate calculations to be stored. The number of inputs and calculations is unlimited.

SUMMARY

An interactive risk analysis program, which is not tied to a particular application and does not require modeling knowledge of the user, has been described in this paper. The ability to perform risk calculations in a manner similar to using a calculator makes the program easy to use and adds flexibility.

The program is currently available on two brands of micro computers and will be on COPPER IMPACT in the near future. For more information concerning the program or its usage contact the author or

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